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Original Research

Comparative evaluation of two placement techniques and adhesive systems on microleakage of class II Composite resin restoration: An In vitro study

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ABSTRACT

Aim: Comparative evaluation of two placement techniques and adhesive systems on Microleakage of class II Composite resin restoration: An In vitro study.
Methods: A comparative study for microleakage in composite restoration using incremental layering technique and bulk fill technique with adhesive system that is total etches and universal bond in combination on 40 extracted maxillary premolar teeth. Cavity II cavity preparation was done. The prepared teeth were randomly divided into four groups according to combinations. Thermal cycled and dipped in 2% Methylene blue dye. The restorations was sectioned and placed under light microscopy. Data collected was computed in Microsoft Excel. Statistical analysis was performed using SPSS.
Result: Statistical analysis indicated that group II farci nano hybrid in incremental layering shows less microleakage with universal bond (group2) followed by (group 1), while (group 3) bulk fill with total etch showed more microleakage.
Conclusion: farci nano hybrid composite in Incremental layering technique is better in prevention of microleakage compare to 3M Espe filtek bulk fill composite.
Clinical Implications- This study is designed to reduction microleakage in class II composite restoration.

Introduction

Recently, composite restorative materials are positioned as creditable alternatives to other dental restoration materials. However, polymerization shrinkage which is one of the major causes of microleakage at the tooth/restorative interface is considered major factor influencing the longevity of the restoration. Hence, polymerization shrinkage of composite resins has to be measured[1,2,6]

To minimize these shrinkage-related complications, many innovative approaches has been introduced in routine practice Interfacial bond strength was also considered a contributing factor (Versluis, Tantbirojn & Douglas, 1998).[3]

Among the bonding systems the fourth generation **Total etches adhesive system** was the first to achieve complete removal of smear layer and still considered as the golden standard in dentin bonding. In this the three primary components (etchant, primer and bonding) are typically packaged in separate containers and applied sequentially. This system was very technique sensitive.[4]

In 2010, Voco America introduced voco futurabond DC as **8th generation universal bonding agent** which was improved to save the timing and better bonding which contains Nano sized fillers with an average particle size of 12 nm which increases the penetration of resin monomers and the hybrid layer thickness.[4]

It is widely accepted that **incremental layering** decreases shrinkage stress as a result of reduced polymerization material volume, each increment is compensated by the next and polymerization shrinkage is less damaging and only related to last layer of the bond

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surface, Thus main factors concur to reduce shrinkage stress use of a small volume of material, and minimal contact with the opposing cavity wall during polymerization.[5]

Although commonly used, oblique Incremental application of composite resins has drawbacks such as risk of void formation and contamination, bond failure between layers, difficult application of composite in conservative cavities and time consuming nature leads to need of newer research .[6]

In an attempt to decrease the microleakage and to shorten the working time resulted in introduction of **bulk fill packable composites**.[6]

So, this study is designed to compare the effect of bonding system total etch and 8th generation universal bonding agent in reduction of microleakage for two different composites placement technique that is bulk fill packable and incremental layering technique in class II composite restoration.[7]

Material and Methodology-

Eighty extracted human maxillary premolars teeth with intact crown were collected from Oral and Maxillofacial surgery department. Samples with incompletely formed apex and caries, cracks, previous restoration, curved roots, previously endodontic treatment were excluded from this study. Selected teeth were sterilized according to OSHA Norms; teeth were mounted on wax block.

Cavity preparation was done mesio–occlusal Class II cavities. The dimensions of prepared cavity was 2 mm deep in occlusal box, width is kept $1/3^{rd}$ the intercuspal distance and an axial wall height of 1.5 mm and 2 mm width at the gingival wall.

Restoration Placement -

The prepared teeth were randomly divided into four groups according to adhesive system and placement technique. Group-1 (n=10): Farci nano hybrid Incremental layering with total etch bond. Group-2 (n=10): Farci nano hybrid Incremental layering technique with tetric universal bond. Group-3 (n =10): 3M ESPE filtek Bulk fill packable with total etch bond.Group-4 (n=10): 3M ESPE filtek Bulk fill packable with tetric universal bond.

In all the four groups following procedure was carried out :

Total etch technique - prepared using 37% phosphoric acid and etch for 20 sec and dentin primer (3M ESPE Adper scotchbond multi-purpose primer) followed by total etch bonding agent .Universal bond technique; Tetric n bond Universal was applied and light activated for 20 sec in 40 samples.

Incremental layering technique-Three successive increments were placed of farci nano hybrid composite in oblique layer techniques.(fig.1) Incremental layering technique was used in 10 samples of total etch and 10 samples of universal.

Bulk fill composite-3M ESPE Filtek Bulk fill restoration was done the prepared cavity was slightly over filled and lightly condensed and light cure. Bulk fill technique was used in 10 samples of total etch and 10 samples of universal adhesive system.

Specimen staining – Acrylic block were made to seal the apical portion of the tooth to prevent dye penetration in pulp chamber. All the surfaces except a rim of 1 mm around the restorations were covered with two layers of nail varnish. Samples were placed in four separate porous bags. The porous bags were then placed in thermal cycling for 500 cycles between 5^0 and 55^0 C with a 30 second. And then placed in 2% Methylene blue dye, and then cleaned with acetone to remove the nail varnish. Sectioning was done

Table -1 : Comparison between groups ANOVA					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	30.938	3	10.313	7.207	0.000
Within Groups	108.750	76	1.431		
Total	139.688	79			

Table 2 comparison between the groups.-

(I) Group	(J) Group	MD (I-J)	Std. Error	Sig.	Result
Group 1	Group 2	.550	.378	.157	Not Significant
	Group 3	-1.15	.378	.019	Significant
	Group 4	-.550	.378	.049	Significant
Group 2	Group 3	-1.700	.378	.000	Significant
	Group 4	-1.100	.378	.005	Significant
Group 3	Group 4	.600	.378	.117	Not Significant

longitudinally in center of restoration mesiodistally and placed under light microscopy.

Measurement on ordinance scale –

Radhika, *et al.*: Marginal microleakage of class II cavities.

Scoring for dye penetration for marginal microleakage on the occlusal wall (fig. 2):

0 - No dye penetration

1 - Dye penetration into enamel

2 - Dye penetration beyond the dentine-enamel junction

3 - Dye penetration into the pulpal wall

Scoring for dye penetration for marginal microleakage on the gingival wall (fig. 3):

0 - No dye penetration

1 - Dye penetration into half extension of cervical wall.

2 -Dye penetration into more than half or complete extension of the cervical wall.

3 - Dye penetration into cervical and axial walls toward the pulp.

These two scores that is marginal and gingival wall were

added for final investigation.

RESULT

The present study was done to evaluate microleakage in composite placement technique and adhesive system. The data was subjected to statistical analysis. Data collected was computed in Microsoft Excel. Statistical analysis was performed using SPSS version 16 for Windows (SPSS Inc, Chicago, IL). Descriptive quantitative data was expressed in mean and standard deviation respectively (table 1).

To study the variation between the groups and within the groups 'ANOVA Test' was used (table no 1).

There was difference in mean penetration depths of the groups. Group III had highest penetration while Group II (farci nano hybrid composite in Incremental layering with universal bond) had lowest penetration depth; the difference between the groups is significant (table no.2, graph 1).

According to result obtained from the present study null hypothesis was rejected as there is variation seen in adhesive system and placement technique.

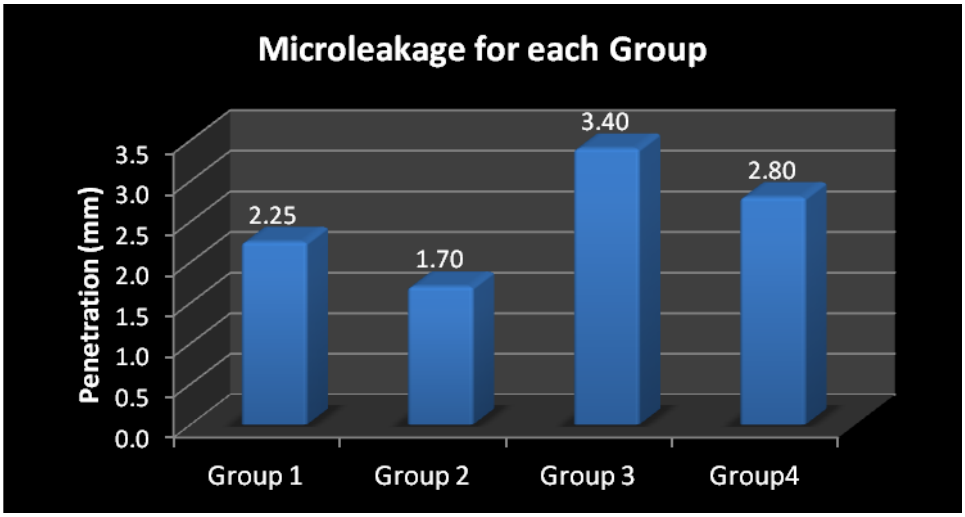
Discussion

The search for an ideal esthetic material for restoring teeth has resulted in significant improvements in esthetic materials that is tooth-colored restoration such as composites such restorations are accomplished with minimal loss of tooth structure with little or no discomfort thus, Composites placement and bonding technique represent two major advances in restorative dentistry.[15]

However, Shrinkage due to polymerization which is one of the major causes of microleakage[1], significant polymerization shrinkage develops during polymerization of composite resins ranging from 1.67 % to 5.68%, producing powerful forces that created separation at the composite resin/ tooth interface. Obtaining such gaps ultimately lead to microleakage which is much challenging for clinician specialty in class II composite restorations [10, 6]

To minimize microleakage from polymerization shrinkage, efforts have been directed towards improving placement techniques and bonding to resolve this problem, so this study is done to comparatively evaluate the microleakage of class II composite restorations in maxillary premolar teeth using two adhesive systems and two placement techniques in combination. [6]

Similar study done by **EMAN I. ALSAGOB(2018)** in which he compared microleakage between bulk-fill flowable and nanofilled incremental layering resin-based composites[1], **Shahram Mosharrafian, Alireza Heidari (2017)** studied Microleakage of Two Bulk Fill and One Conventional Composite in Class II Restorations. In this study we have checked microleakage in incremental



Graph 1: Microleakage of each group-

Fig. 1 Incremental layering was placed of farci nano hybrid composite in proximal box.

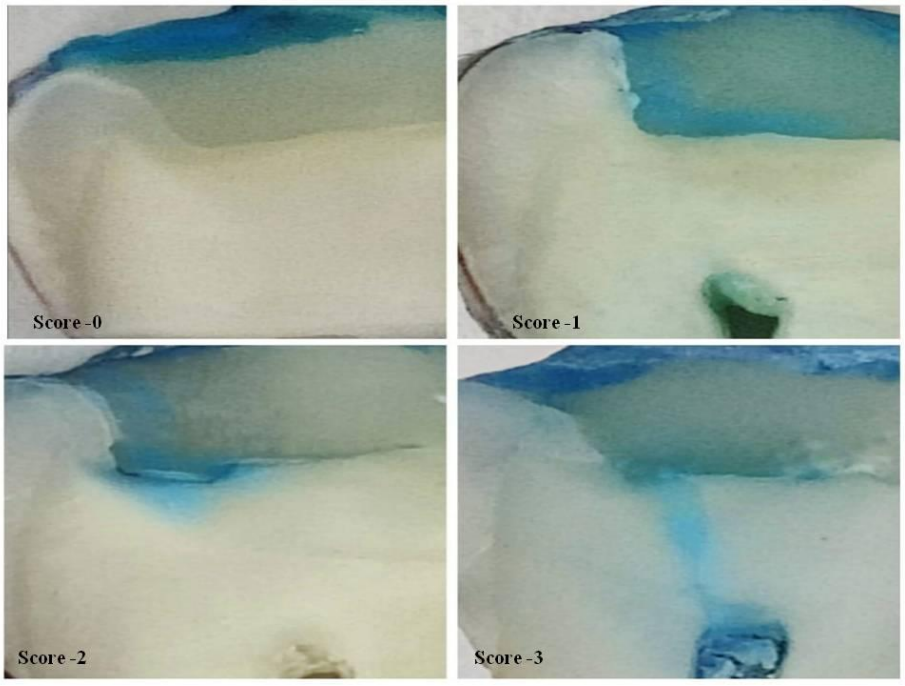


Fig. 2 scoring for dye penetration for marginal microleakage on the Occlusal wall.

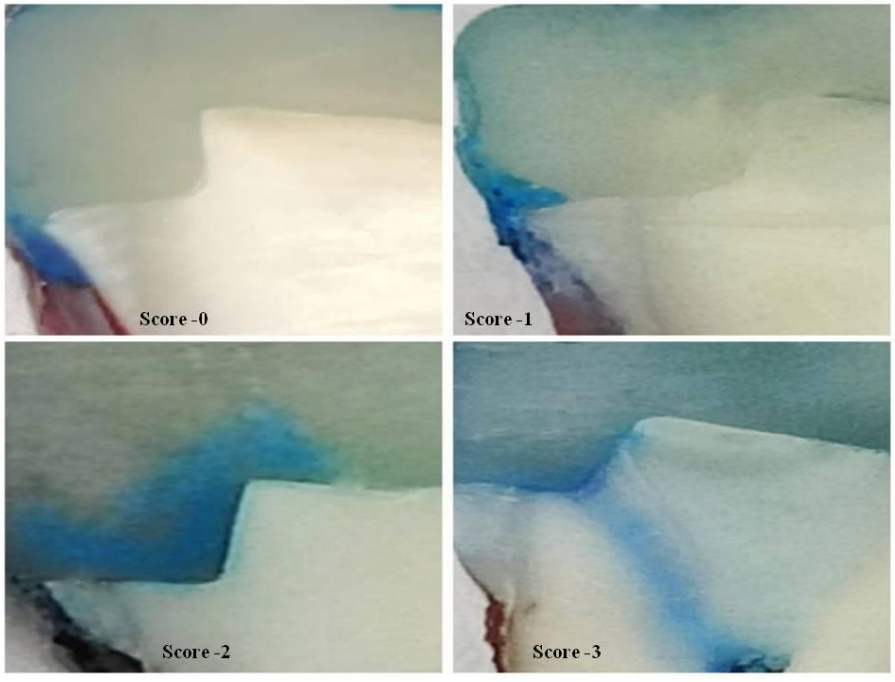


Fig. 3 Scoring for dye penetration for marginal microleakage on the gingival wall.

layering and bulk fill with combination of adhesive system. [6]

Restoration placement techniques are universally recognized as a considerable factor in the modification of shrinkage stress. So placing the composite in incremental layers is recommended to reduce shrinkage stress. [5]

According to **Veeramachaneni Chandrasekhar, Laharika Rudrapati (2017)** it is widely accepted that incremental layering decreases shrinkage stress as a result of reduced polymerization material volume.[5]

The use of oblique layering techniques are recommended for restorations 3 to 4 mm in depth, Incremental placement also reduces contraction stresses during polymerization of composite resins. Hence, we used oblique layering technique.[10, 7,5.]

Problems related to incremental technique are the limited depth of the cure, technique sensitivity and time-consuming placement procedure. Bulk-fill composite resins seem to fulfill this desire hence, in this study the Bulk-fill technique was used in comparison with incremental layering techique.[12]

According to clinical experience disadvantage of Bulk insertion is it causes the bulk of the restorative to shrink toward the enamel margin, consequently pulling away from the weaker bond, with creation of micro gaps and marginal leakage.[15]

The development of an adhesive system in restorative dentistry has been thought to be another advantage for reduction in microleakage. In the present study we have used total etch bond and universal bonding system to check if there is any improvement with incremental or bulk fill.[15]

One of the Study done by **Widya Saraswati, Dian Pramita Ayu Kumalasari and Adioro Soetojo(2019)** and concluded that total etch shows less microleakage than other self etching agents. [13]

However, total etch system can be very confusing and time consuming because of the complexity of multiple bottles and hence, dentists began to request a simplified adhesive systems.[4]

To overcome complications related to total etch bonding system, Introduction of universal bonding agent was done to save the time and better bonding which contains nano sized fillers.

In the present study we have used tetric n bond universal in self etch mode as described by the manufacturer and according to **Gabriela Cardoso, de Cardoso(2019)** used universal bond in both Etch And-Rinse or Self-Etch Strategies stated that the bonding performance of universal adhesives is comparable to the gold standard materials, particularly when applied in the self-etch mode. Hence in the present study we have used universal bond in self etch mode so, it can be correlated with study done by self etch adhesive system.[22] **Abdullah Saleh Aljamhan, Sultan Ali Alhazzaa(2021)** stated that self-etch adhesive system showed significant reduction in micro-leakage compared to the total-etch system. [14]

The above mentioned bonding agent and placement technique where then used in combination as incremental with total etch (group1), incremental with universal (group 2), bulk fill with total etch (group3) and bulk fill with universal (group4).

In the present study, we have used methylene blue dye for detection of microleakage, **Asmaa A. Desouky1, Maged M. Negm (2019)** stated that Methylene blue dye was considered suitable for the detection of microleakage due to having a molecular size similar to or smaller than that of bacterial products.[11]

The sample prepared by combination was simulate

to oral cavity conditions, the thermo cycling test was performed and the teeth kept at 37°C and 100% humidity during procedures.[8]

500 thermo cycles at 55°C and 5°C to simulate oral cavity conditions. In the present study, the temperature and number of thermal cycling was based on Barnes' et al study.[9]

In the present study we have sectioned tooth longitudinally in mesio-distal direction and used ordinance scale for measuring microleakage in occlusal and gingival wall which is according to study done by **Radhika M et al. (2009)**[7], Dye penetration was measured using a light Microscope which was done according to study done by **Peter Kuyaya Welime(2014)** [9].

Thus according to this incremental with total etch (group 1) and incremental with universal bond (group2) shows no Statistical difference in our study, also According to **Barry M. Owens (2005)**[15],**Tjan et al(1992)** [10] stated that incremental layering shows better result than bulk fill.

Incremental with total etch bonding agent(group 1) showed better statistical result then bulk fill with total etch (group3) these findings are similar to findings by **Barry M. owens (2005)** [15] this finding is contradict to study done by **AR Yazici SA Antonson (2016)**.[18]

Incremental with total etch (group 1) showed statistically higher result then bulk fills with universal bond (group4). This finding is contradictory with **Puckett et al** who found no significant difference between oblique incremental and bulk techniques[21], while according to **Anthony H. L. Tjan, DrDent, DDS (1992)** stated that none of the incremental placement methods significantly improved adaptation at the gingival margins compared with the one-bulk technique.[10] In the present study, the self-etch universal adhesive system shows superior result in dentin sealing than the total-etch system which is contradict to our finding , this is in agreement with **Ozer F(2013)**, who recommended the use of self-etch adhesive in dentin.[20]

Incremental with universal self etch (group 2)show better result than bulk fill with total etch(group3) ,this finding is similar to the study done by **Abdullah Saleh Aljamhan , Sultan Ali Alhazzaa (2021)** [17]

Incremental with universal bond (group2) shows better result than bulk fill with universal (group4) this finding is similar to study was done by **M. Moezyzadeh, M. Kazemipoor(2009)** stated oblique filling technique resulted in a lower leakage value, when compared to the bulk filling technique.[16] Another study with similar findings was done by **EMAN I. ALSAGOB (2018)** he found that conventional nano hybrid composite exhibited the least microleakage than bulk fill. However, the conventional nano hybrid composite is still more predictable to use.[1]

Bulk fill with total etch shows no statistical difference when compare to bulk fill with universal according to **Armiliana Soares NASCIMENTO, Eliane Alves de LIMA(2016)** Evaluated Marginal microleakage in Bulk Fill resins and Concluded that degree of leakage of the bulk fill resins studied, in class II cavities, was not influenced by the method of application of the adhesive system, except for the Filtek Bulk fill flow.[19]

Conclusion

Within the limitations of this in vitro study following conclusions are drawn- None of the groups showed complete prevention of microleakage. Incremental layering technique showed better prevention of microleakage than 3M bulk fill. farci nano hybrid composite in Incremental layering with universal bond (group 2) showed better result than rest of the group. Bulk fill with total etch (group 3) showed highest microleakage compare to any other group. Total etch showed more microleakage then universal bond with both incremental layering and bulk fill technique. When comparing similar placement technique that is incremental with total etch (group1) and incremental with universal (group2) come to be not significant this may be due to influence of bonding agent as universal showed better

result than total etch, similar finding was seen with bulk fill that is (group3) with (group 4).

For the final conclusion further *in vivo* studies should be done to evaluate the efficacy of placement technique and adhesive system from teeth with different anatomies measured by different strategies.

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